Visual cues in straight road driving

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SUMMARY

The present study investigates what visual information a driver needs in order to be able to steer his car on a straight road.

In Chapter 1 this question is addressed by reviewing the literature on control models of drivers and on the perception of egomotion.

Control models in general do not take into account the complex perspective transformations which determine the possibilities for perception, while the perceptual theories in general only encompass a restricted range of situations and tasks.

In Chapter 2 a detailed analysis is presented of the possibilities a moving observer has to perceive his egomotion. The general formulation of this problem allows for a more unified discussion of earlier formulations. It is argued tht the earlier formulations in general are not applicable to the car driving situation, because they either neglect the effects of the rotational velocities or the effects of visual guidance provided by the road and the road delineation. This makes a more specific analysis necessary. On the basis of this analysis a number of hypotheses about visual cues for straight road driving are developed.

In Chapter 3 a laboratory experiment is described in which thresholds for the perception of two relevant dynamic visual cues are determined. These are the optical effects of lateral speed and of heading rate as they must be discerned against the 'background' optical flow due to rectilinear movement of the observer in two types of environment, one consisting of a varying number of randomly placed environmental points, the other of a two lane road delineated in a conventional way.

For the simulated road environment the obtained thresholds were low enough to be compatible with the precision of normal driving. For the random point environments only the optical effects of heading rate could be perceived with sufficient precision.

These results permit the conclusion that both cues can be functional in straight road driving.

In Chapter 4 an experiment is presented aimed at determining whether the proposed visual cues are actually used during straight road driving. By manipulating the visual environment and the available visual field the perceptability of the various cues was varied and the effects on driving registered.

The results show that the optical correlates of lateral speed, lateral position and heading rate are used in course control. It also appears likely that the heading angle itself is not controlled directly but remains within a small range as a consequence of controlling the other cues

mentioned. Unexperienced drivers seem not to use the available cue of lateral speed.

In Chapter 5 a method is developed and tested that uncouples the perception of lateral position from that of lateral speed. The literature on motion perception suggests that direct movement perception is still possible at a 25 Hz stroboscopic occlusion rate, but not at a 5 Hz rate. However, at the latter rate the perception of position cues should still be intact.

This suggestion was tested by determining thresholds for movement perception for movement against structured and unstructured backgrounds and with 25 Hz and 5 Hz occlusion rates.

A considerable rise in threshold value in the 5 Hz rate, unstructured background condition was found, confirming the expectation.

In Chapter 6 an experiment is described in which the method of stroboscopic occlusion was used during actual driving. The main result of this experiment is that information about lateral position is by itself insufficient for keeping the car between the lane boundaries.

In the final chapter a general discussion of the findings is presented. The possibilities for integrating these findings in control models are discussed. Suggestions are given for the application of the results to problems of traffic safety.